Real-Time Positional Control Technologies

In the course of Area B remediation and closure at Ashtabula, buildings will be taken down, concrete pads potentially scanned and cleared, and soils excavated, remediated, and closed. The use of real-time data collection technologies can have a significant impact on the efficiency and effectiveness of these remediation and closure activities. However, effective use of real-time scanning and direct measurement technologies presumes the ability to log data as it is collected, and match that data with positional control information to support post-data collection analysis and data presentation.

There are basically four options for providing real-time positional control in support of real-time data collection. These include the use of distance-traveled meters, differentially corrected global positioning systems (DGPS), broadcasting laser systems, and laser-based tracking total stations.

Distance-Traveled Meters

Distance-traveled systems are based on the simple principal that if data collection moves along a predetermined path, and if distance traveled along that path can be measured and matched with a sensor reading, then one can determine the location of the reading. Distance-traveled systems are typically deployed on wheeled systems (e.g., floor scanning technologies) that travel along straight lines. The use of a wheeled system allows direct measurement of distance traveled by logging wheel revolutions. An example of this type of system is the Shonka Surface Contamination Monitor (http://www.shonka.com/Products/SCM/SCM.htm). The use of this type of system presumes that one has a path marked out for travel. If one would like to integrate the results logged by this type of survey with other site features, one also needs a way of transforming the local coordinate system used for the survey to whatever coordinate system is applied to the site. This type of system can be particularly effective, however, for data collection over floors where maintaining straight scanning lines is possible, and where implementing more sophisticated techniques such as DGPS is problematic because of structures. Relatively high x,y accuracy can be obtained from a location perspective. These systems provide no elevation information.

Differentially-Corrected Global Positioning Systems

Differentially-corrected global positioning systems make use of the global positioning system satellite network to pinpoint locations. Differential correction provides locations with an accuracy of approximately +/- five feet in the horizontal plane, however accuracy is significantly poorer for elevations. Locations are provided in latitude and longitude. Locational information may need to be transformed to match the coordinate system in use at the site. The use of these systems presumes clear satellite locks with at least four satellites. Performance of these systems can be compromised by satellite loss, which can occur because of obstructions caused by buildings or tall trees. These systems are on the order of $10K to purchase, and can be connected to almost any sensor to provide locational control. They are particularly effective for large area data collection over soil surfaces where the inherent location errors are not of significant concern. They are now commonly used across the DOE complex and within the USACE FUSRAP program for supporting gamma walkover surveys of sites. They are more problematic for concrete surface scans where a five foot error in location can be significant.

Survey-quality location control can be obtained by upgrading these systems with additional base stations. While this adds significant cost to the system, location errors in all three directions can be reduced to less than a centimeter.

The site currently is in possession of a Trimble DGPS system.

Broadcasting Laser Systems

Broadcasting laser systems make use of stationary laser broadcasting units and a “smart” wand that determines position based on these broadcasts. Minimal requirements include two broadcasting stations and one wand. The cost for these types of systems is on the order of $30K to purchase. They can be rented

for approximately $2500 per month. The strength of this technology is its accuracy in all three dimensions, independence of satellites to establish control, support for more than one "walker" using just two base stations, and the fact that the wand is carried by the walker, meaning that locations and sensor data are generated and logged at the same point. The weaknesses are that line of sight must be maintained between base station and walker, and the effective distance is limited to a 50 meter radius from the base stations. These systems were originally developed to support the development of "as built" interior drawings for buildings (e.g., mapping piping, ductwork, structural members, etc.) This type of system from ArcSecond is currently being deployed at the Fernald site with ASTD funding to support real-time data collection there.

Traditional laser-based civil surveying equipment such as total stations can also be upgraded to allow for tracking of moving targets, such as a technician performing a walkover survey of soils or pushing a floor monitor across concrete. The cost of these systems is on the order of $30K to purchase. They can be rented for approximately $2500 per month. The strength of this technology is its accuracy in all three dimensions, the need for only one base station, and the fact that it does not rely on satellites to establish control, and so is unaffected by buildings, topography or trees. The drawbacks of this technology are its requirement that line of sight be maintained between tracking station and technician, and the fact that an FM communication device is required to match location information (generated at the base station) with sensor data (generated by the technician). ANL is currently developing a gamma walkover survey system based on this technology for U.S. EPA Region 5 using Leica equipment. TopCon also has a robotic position tracking system with a tracking range of 1,200 feet and automatic lock loss recovery.